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ABSTRACT

Two model programs have been develcped for preservice and inservice training of teachers in the instructional applications of computers. The preservice model features a background in computer science, fcundations of instructional computing using a total school view and content specific view, a task-centered practicum in instructional computing, and practice teaching. The inservice training model consists of three stages: (1) initial literacy, (2) implementation, and (3) maintenance or growth. Curriculum maps are provided for both programs and three references are listed. (CMV)

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The Illinois Series on Educational Application of Computers

TEACHER EDUCATION IN USE OF COMPUTERS

J.Richard Dennis

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To the reader,

This is one of a series of documents prepared as resources for the preservice and inservice training of teachers. The general theme of all items in this series is "teaching with or about computers". The booklets are the collective work of a variety of staff and students (both present and former) of the College of Education, University of Illinois at Urbana-Champaign. The project generously was supported between 1977 and 1979 by a grant from the EXXON Education Foundation. All resposibility for the content of these documents rests with the authors and does not reflect necessarily the views of the EXXON Foundation. It was my extreme pleasure to direct this effort throughout.

J.Richard Dennis, PhD
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INTRODUCTION

This is the first in a series of reports resulting from research focused on alternative programs in undergraduate teacher education. This research was initiated by the Department of Secondary Education, University of Illinois at a time when enrollment both in undergraduate teaching programs and graduate professional education significantly was changing.

Conventionally, preservice teacher education programs have been consistent on at least two attributes:

1. Subject concentrations offered the trainee knowledge eventually to be delivered to others.

2. Matters related to the act of instruction itself almost unanimously have been concerned with lecture style delivery.

Subject minor concentrations also have been included in teacher training for some time. State certification procedures recognize minor teaching concentrations and school administrators make some employment decisions on the basis of the potential for alternate assignments.

This training model has worked well so long as the mode of public education has remained relatively static in form. The past few decades, however, have seen the emergence of several instructional methods or plans that promised the schools new alternatives for those apparently not adequately served by the conventional one. In each such case, the method has been complex and has required assimilation of significantly different teaching behaviors. Attempts have been made to establish such behaviors both at the preservice and the inservice levels. Efforts at both levels have met with less than desired success. Preservice attempts normally have taken the form of including presentations of new teaching models in existing course structures. Inservice efforts normally have been structured around workshops or extramural courses. Both approaches to altering teaching behaviors have lacked the intensity and duration to guarantee establishment of new classroom habits. A few teachers have achieved new teaching styles for themselves but usually only through excessive personal investment and effort. The number of teachers willing or able to invest to this level is quite small. It is understandable that such educational innovations have failed to realize broad impact in practice.

A Model for Teaching Professional Specialties

For individual teachers to acquire significantly new or different teaching behaviors requires training of a duration and at a level of intensity difficult to achieve at several levels of professional activity. For inservice personnel, probably only sabbatical study or summer programs could achieve the dedication and attention to training required. Both of these training configurations are rare, if not nonexistent, within today's school resources. Such particularly is so if implementation of alternatives is sought across a diverse selection of teachers.

The preservice picture is not so constrained. Properly orchestrated, teachers in training can sustain intense levels of attention to a subject for a considerable duration. The orchestration of these learning experiences is the task of the teacher educator. One successful model for this orchestration, and the focus of the research reported here, takes the form of an undergraduate professional minor. However, for these purposes we must alter our view of the undergraduate minor as it relates to potential teachers. We are NOT talking of minors intended to provide the individual with alternate knowledge to teach others. Rather, we speak of concentrations to provide expanded or alternative techniques for teaching knowledge to others. There is a wide variety of potential foci for these professional minors, including audio-tutorial instruction, radio-television instruction, film studies and techniques, alternatives for urban education, open classroom instruction, etc. All of these professional competencies have in common the following components:

1. A significant bachground "technology" and/or related learning research literature requiring study in its own right.

2. An acquired repertoir of professional behaviors, perceptions, and decision structures.

3. A requirement for critiqued practice during initial personal implementations of the professional behaviors.

The focus chosen to pilot our research on professional minors is teaching with a computer. For this instance of the model, the background technology is computer science and the related learning literatures are instructional design, expediting mastery learning, optimizing testing, instruction via simulation to mention a few. Also, critiqued practice is required in designing automated interactive dialogue, in integrating instructional media with other classroom operations, and in evaluating resources intended to facilitate these professional behaviors.

Identifying Training Needs of the Computer Using Teacher

At the time this project began, the literature of educational computing was dominated by reports and plans for training teachers to teach others to use a computer. This is what we (and others) have come to call teaching about computers. What one usually does in this type of effort is to teach computer programming skills to others. Although an important activity for schools to entertain, teaching about computers mostly is outside the realm of our concern here. The main reason for this is that to teach computer programming and other related computer science topics, one properly should have training equivalent at least to a minor teaching concentration in computer science (about 20 or so semester hours of planned coursework). Over the next several years, we shall see a steady growth in the number of states instituting full scale computer science teaching majors and the accompanying teacher certification.

Our concerns here are in training educators to teach with computers. This means to use the computer in ways that help the teacher or help learning but may not impart to students much in the way of details about what a computer is, what one will do, or how one is made to do these things.

In addressing the question of the desirable training goals for those who will become computer using teachers, there was little in the way of guidelines on which to design a program. Perceptions of such goals appeared to be held, but were unarticulated, among two audiences. First, there was a group of teachers who already were active participants in instructional computing. The means through which these people derived their expertise varied widely. Many of them had learned through heavy investments of their own time in self instruction and experimentation. We shall refer to these persons as "active participants".

The second group holding opinions regarding training needs of those who would teach with computers is one we shall refer to as "university-academic" experts. These are the persons on college campuses and elsewhere who publish research reports and/or recommendations about instructional uses of computers. Included in this group are persons in the related publishing and equipment vending industries.

Each of these types of individual has definite views on the nature of computer uses in schools and the talents needed to effect same. Teachers who are active participants might be expected to be concerned more with the practical aspects of how the computer can and is being used on a daily basis. In contrast, the university-academic likely will be more concerned with how the computer might or should be used for instruction. Consequently,

these groups hold differing opinions about the training needed by a computer using teacher.

To determine necessary teacher training content in this area, a research study was conducted by questionaire among both active participants and university-academics (Baum, 1978). The procedure used in this study was a modification of the Delphi technique often used to achieve a consensus among a geographically separate group of experts on likely future developments of a particular type (Linstone and Turoff, 1977). The usual form of a Delphi study is to ask experts the date in which a particular event will occur. After tabulation, all persons whose estimate is outside the interquartile range are sent a second form giving them the opportunity to rethink and change their estimate, or to explain their reasons for maintaining a divergent position. Usually, this process continues through several contacts. The plan is designed to offer the advantages of a conference of experts without the difficulty and expense of bringing the group together. Also, the plan minimizes the effects that personality influences and dominance can have in a group conference.

In the Baum study of training needs of computer using teachers, the procedure more was that of the Policy Delphi technique. This less common form is used to clarify the facets of a complex issue, to educate members of a community on the positions and viewpoints of the other members, or to present options and supporting evidence in a decision-making situation. The Policy Delphi method still involves successive rounds of questionaires. Respondents are asked to rate or to rank items according to a criterion. When answers of a respondent do not coincide with those of the majority, they are given an opportunity to change or to explain their positions. In short, the method offers an organized way to gather positions and information on an issue.

Both active participants and university-academic respondents were asked to rate each of a list of skills or knowledge regarding teaching with computers. This rating was done on a four position scale from "very important for computer-using teachers to have" to "not important for computer-using teachers to have". Respondents also could add items to the list. These ratings were tabulated to determine majority views. Then those respondents having a non-majority position on an item were contacted. The second contact offered the opportunity to rethink and to join the majority position, or to offer reasons for maintaining a non-majority position.

Based upon the Baum study, the following non-hierachical knowledge or skills needed by computer-using teachers were identified:

1. Familiarity with computerized teaching materials (i.e., instructional programs) in a variety of fields.

2. Ability to integrate computerized teaching materials into a course.

3. General knowledge of the functioning of CMI (computer managed instruction) systems.

4. Understanding of effective design of drill and practice materials.

5. Ability to apply computerized drill and practice in a variety of teaching situations.

6. Familiarity with computer simulations and models.

7. Experience in preliminary design and construction of a simulation.

8. Knowledge of the uses of simulations as teaching tools.

9. Ability to evaluate the effectiveness of a course that uses computerized teaching materials.

10. Ability to determine the computer needs of a school.

11. Ability to draft specifications (request for proposals) which set down the needs and desires of the school and invite proposals or bids from potential suppliers.

12. Ability to be highly critical of suppliers' proposals and their machines.

13. Ability to assemble data about proposed equipment to facilitate decision-making (costs, performance data, hardware characteristics, software support, etc).

14. Familiarity with instructional games.

15. Knowledge of how to use instructional games appropriately and effectively in teaching.

16. Physical familiarity with computer equipment, i.e., everyday operation and use of a range of different machines.

17. Knowledge of trouble shooting procedures and means of access to professional help, i.e., knowing how to determine if a piece of equipment is ailing, if it is, knowing whom to call to fix it.

18. Knowledge of sources for computer materials.

19. Knowledge of how to improve less than adequate instructional computer programs.

20. Ability to evaluate the effectiveness of instructional computer programs.

21. Ability to instruct others in the social role and impact of computers in society.

22. Knowledge of alternative uses of computers in schools, i.e., as class record-keepers, term paper editors, etc.

23. Awareness of the value of involving students in the development of computerized instructional materials.

24. Knowledge of processes of involving student in instructional materials development.

25. Knowledge of computer programming.

A Professional Specialty Program in Instructional Computing

We present here a program for preservice training of teachers in instructional application of computers (IAC). This program is an instance of preservice professional concentration discussed above. The general goals of the program are:

1. Technical background in computer programming.

2. An across the school perspective of instructional computing, plus an intensive exposure to methods of teaching one's own subject with computers.

3. Knowledge of pertinent research and findings in areas such as learning, teaching, curriculum, and evaluation.

4. Basic hardware knowledge implied by school operation of computers.

5. Opportunities for direct experiences with instruction via computers.

From a more detailed point of view, the instructional computing program consists of five parts extending for at least four semesters. Following are detailed descriptions of the parts:

I. Background in Computer Science

Normally, this consists of a beginning and and advanced undergraduate programming course, Generally, the goal of this part of the program is to develop reasonable skill as a computer programmer. In addition, there may be electives in computer science selected from among advanced systems programming, hardware, numerical analysis, logic design, or an applications course relevant both to educational computing and to the teaching major. These electives would be included and chosen to the extent that program time would permit.

Incorporated in such an experience should be instruction in the use of data files of the major types (sequential, random access, and indexed or structured (ISAM) files). Those who likely will encounter micro-computers will benefit from a modicum of experience with assembly languages. Included should be an overview of the functions and relationships of operating systems, monitor level command options, and high level programming

languages. Most colleges and universities today have one or more courses that include these topics. The caution is, however, to remember that the audience here is composed of people who will be applying computers to a particular endeavor. At this point in time, making such experiences so abstract or technical that only a very few teachers successfully complete them would serve only to impede seriously the impact of this instructional technology on schooling.

II. Foundations of Instructional Computing: The Total School View

1. The literature and existing resources of instructional computing

2. Survey and analysis of the variety of educational uses of computers and general characteristics of each (computer managed instruction, drill and practice, tutorial, simulations, instructional games, problem solving, evaluation and test item banking, record keeping and processing).

3. Studies of various hardware characteristics, capabilities, and the effects on school application. Consideration of specific instructional activities as they would be implemented by alternate hardware systems, and the accompanying changes in teacher behavior and responsibilities. The systems considered include programmable calculators, micro-computers, and large scale network systems. Included is a thorough consideration of both batch and interactive instructional applications.

4. Reviews of relevant research on learning, teaching, curriculum, and evaluation.

5. Social and legal implications of computers in schools and society, privacy, computer security, computers in the home.

6. Models of system management and operation in schools; implications for personnel access and management.

7. Strategies and issues in hardware/software procurement and maintenance.

8. Authoring languages for IAC (e.g., TUTOR, BASIC, IDF, CAISP, VOCAL, PILOT). Characteristics and techniques of authoring in such languages.

III. Instructional Computing: The Content Specific View

An array of one semester courses sectioned to be specific to the teaching major of the student.

1. A critical survey and analysis of instructional computing within the content area of the teaching major.

2. Integrating instructional systems and classroom instruction; role analysis and designation within classroom management models peculiar to the discipline.

3. Design and evaluation of courseware in the teaching major.

4. Automating evaluation and record keeping in the discipline.

5. Projects and materials design.

IV. Task-Centered Practicum in Instructional Computing

An opportunity for repetition of fundamental practice skills. Teacher competencies are defined in the following categories:

1. Preparation and use of controlled, interactive, computer based instruction.

2. Preparation and use of computer managed instruction.

3. Design, implementation and utilization of simulations.

4. Facilitating computer problem solving.

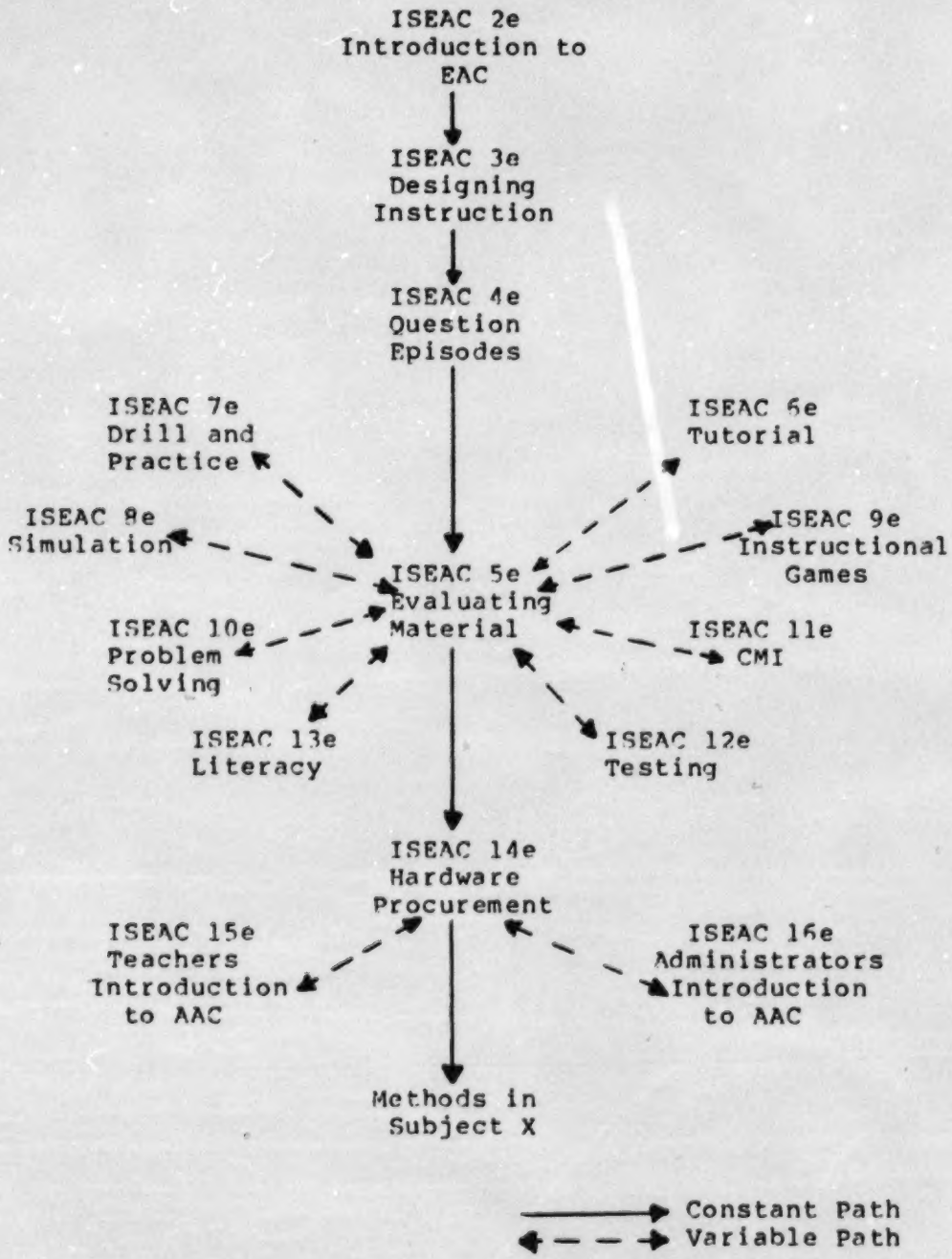
5. Prescribing student evaluation and record keeping.

6. Resource allocation and management.

V. Practice Teaching

Students practice teach in schools having instructional computers available. Of course, participants all practice in their subject major.

A perspective teacher's initial introduction to instructional use of computers is best couched from the broad view of the school, rather than the narrow view of their subject. In such a course, prospective teachers of all subjects should be together to benefit from each other's values, concerns, and likely applications of instructional systems. The general content of such an experience and a successful curriculum map is shown below. (The basis of this experience is to be found in the ISEAC papers numbers 2e-15e, subsequent monographs in this series).



CURRICULUM MAP FOR FOUNDATIONS
OF IAC EXPERIENCE
(PRE-SERVICE)

FIGURE 1

Following the whole school introduction to instructional computing, preservice teachers are prepared to benefit from an intensive look at methods of teaching their own subject with a computer. We have argued for this order of events at the preservice level in order to get the IAC subject methods experience more closely related to conventional methods experiences of teacher education programs. (Resources for some of the IAC subject methods experiences are found in ISEACS 17e-20e). As IAC perspectives in other subjects become more established, similar resources will become available.

For the preservice teacher, the temporal arrangement of all these components may take either a linear form or a delayed entry form depending upon the time available in the undergraduate curriculum (refer Figure 2).

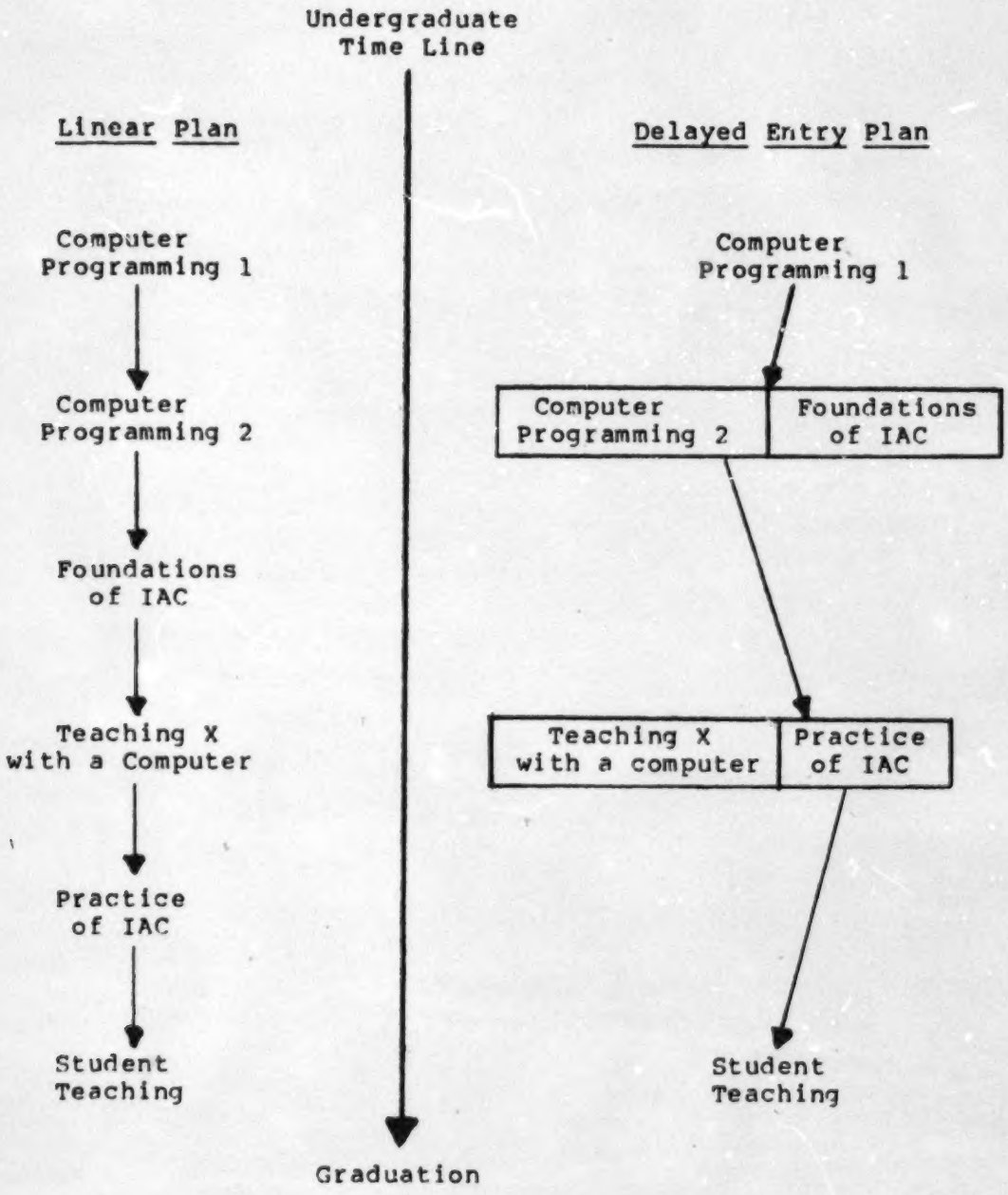

Undergraduate
Time Line
Linear Plan
Computer
Programming 1
Computer
Programming 2
Foundations
of IAC
Teaching X
with a Computer
Practice
of IAC
Student
Teaching
Graduation
Delayed Entry Plan
Computer
Programming 1
Computer
Programming 2
Foundations
of IAC
Teaching X
with a computer
Practice
of IAC
Student
Teaching

FIGURE 2

Bringing Computers into a Teacher's College

The previous discussion presents several views of the needs of pre-college education as it collectively moves to integrate technology into the arena of instruction. The discussion was presented from the perspective of a college of education that has been involved in such training both preservice and inservice for a considerable period of time. To say that the talents required for conducting such training programs did not just suddenly appear is a gross understatement. The natural first question for the teacher's college not now involved in computing technology is "What are some reasonable starting-up strategies?"

First, let us advise that both from the perspective of a public school and from that of a teacher's college, the introduction of computers into education should be an interdisciplinary matter. A small team, consisting of, say, any combination of a mathematics educator, a social studies educator, a science educator, a language or English educator, and/or (if possible) an educator of administrators should address this frontier together. Too often in the public schools, computers have been introduced and have become the emminent domain of just one or two teachers or of a single discipline. Computers offer a potential to every teacher; that potential only must be realized and developed.

The second piece of advice we give to the teacher educator (as well as to the public school teacher) is to involve your students at the outset--at the earliest possible moments. Applying technology to any endeavor is much more than an intellectual exercise. The technology is much too rich and multi-faceted to be comprehended through the looking glass of independent thought. Some direct experience must accrue. However, in a collective, each individual may pursue different avenues of such activity and greatly accelerate the accumulation of the experiential base of the group. Also, students learn best when working on real problems. The problem at hand is bringing technology into education. What better experience for the potential educator than to be an active participant in solving the problems of bringing technology into teacher education.

Another important reason for combined faculty efforts and very early involvement of students is one of a critical mass of development personnel. Bringing computers into any sector of activity requires tremendous effort in developing appropriate resources and interfaces. These interfaces for education come in a variety of forms, including curricular plans, activities, computerized teaching materials, utility computer programs, and so on. At this point in time, very few sources of prepared interfaces exist. Thus development effort can be an important part of your teacher education program.

The monographs in this series greatly can expedite early efforts of the teacher educator. A detailed introduction to each of the potentially valuable instructional computing styles is presented. Related research has been drawn together and condensed to specific application design priciples. Also, these are accompanied by several ready to implement computer teaching interfaces. Gaining experience with both the implementation and the utilization of these facilities is a good place for the teacher educator to begin efforts at bringing technology into education in effective ways.

Inservice Training in Instructional Computing

As this research has unfolded, we also have sharpened our view of the requirements for effective inservice training in matters as complex as alternative professional behaviors. We still view the task of becoming a computer using teacher while on the job as many times more difficult than achieving the expertise preservice. However, for teachers already in the field, there may be no alternative.

For the practicing teacher, training for classroom use of computers requires special consideration of the job context and of the constraints on personal time and energy already present. With such constraints in mind, we shall describe three stages of inservice training designed to bring a practicing teacher to a level of competence in teaching with computers. These stages are:

1. Initial Literacy Stage
2. Implementing Stage
3. Maintenance or Growth Stage

Each of these stages has unique information needs and specific ability goals to be achieved.

At the initial literacy stage, two types of teachers are encountered. First, there are teachers not yet personally active in computing who teach in schools already having instructional computing resources. The second type of teacher encountered is the one from a school not yet having instructional computers. Both of these teachers are very much interested in the question:

What could I do with an instructional computer?

For the teacher from an as yet unequipped school, there is an almost equally important question to address at the literacy stage:

> How would my school procede to get an instructional computer if desired?

For both of these teachers, ideas are needed on how a computer can support or facilitate instruction. However, one must keep in mind that seldom do these teachers have much background or even working vocabulary for computers. So, suggestions must be framed in the context of day-to-day instruction itself, with very little technical references to the computer. (An example of one resource for the initial literacy stage is found in ISEAC 2e). Generally, such an information program is the subject of a session lasting only a few hours. An essential attribute of such a program is the opportunity to view and to experience first-hand a variety of activities conducted in this instructional mode. Such examples should be chosen from materials that have had actual classroom use and, wherever possible, should include some description or other information regarding how the computer activity is integrated with (and benefits) regular instruction.

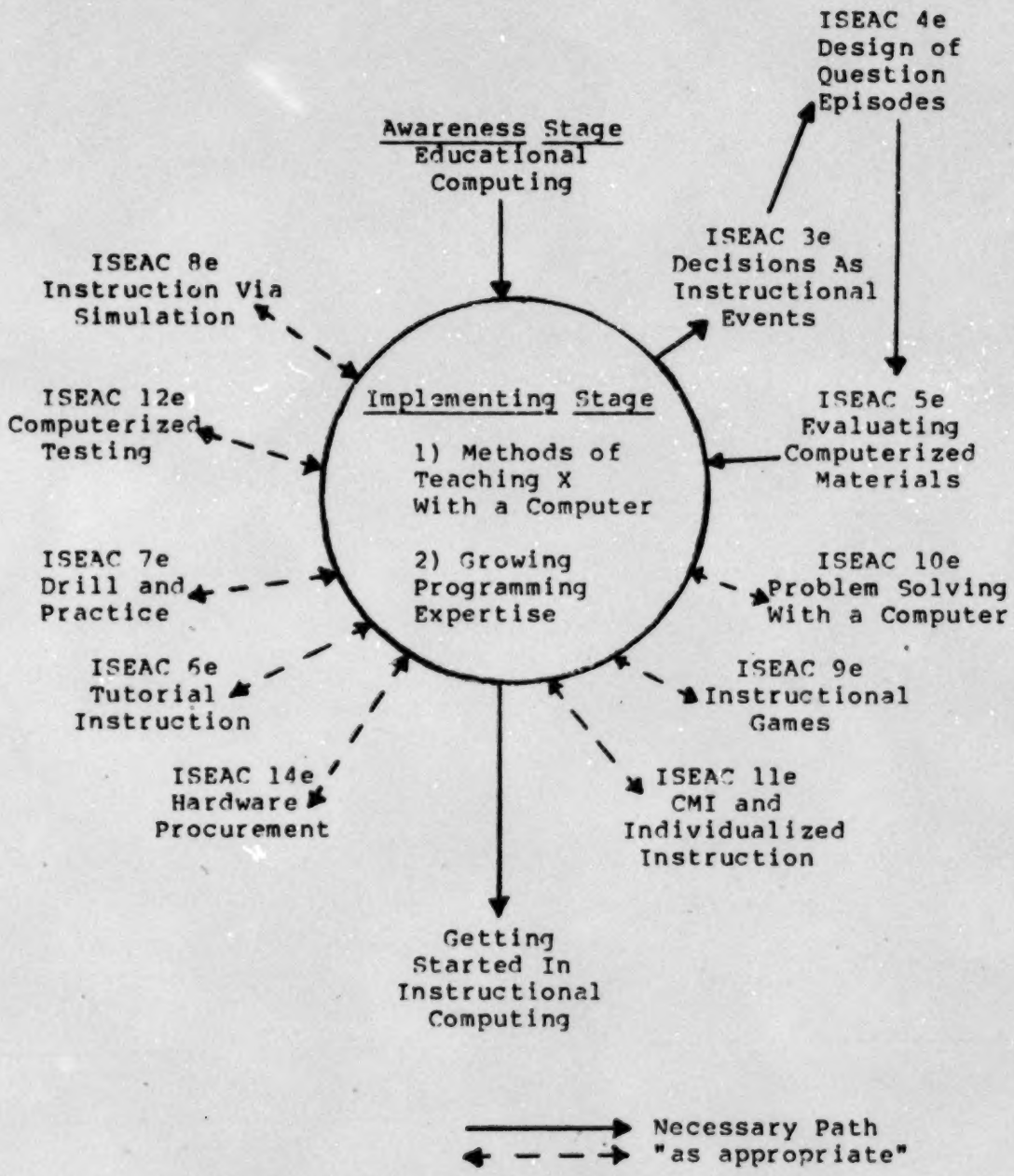
For the teacher not currently in a computer equipped context, a literacy program also should include a discussion of methods others have used to bring computers into a school, along with a rationale for same. For this type of teacher, it is almost mandatory that a responsible administrator be a co-participant in the literacy activities. Both the teacher and the administrator should be made aware of the need to define, as explicitly as possible, the uses they will make of a computer before attempting to purchase major amounts of equipment. In the absence of such a careful procedure, the risks are great of acquiring equipment in some way incompatible with desired uses likely to emerge later.

Inservice teachers at the implementing stage of instructional computing need two kinds of training, both of which require rather intensive commitments for a period of time. One of these is a detailed look at instructional computing methods and their characteristics. Integrated with this training should be a growing expertise with instructional programming. The inservice teacher is much more action oriented than the preservice counterpart. In most cases, this precludes a succession of experiences from programming instruction to intensive looks at computerized instruction. For the inservice person, we recommend the integration and simultaneous growth of these abilities so that classroom implementation (and experiences) may begin very early in the training period.

For gaining background in computing, one technique that is very productive from the inservice teacher's point of view is to progress from reproducing instructional programs created elsewhere, to creating original instances oneself. In this way, the teacher can learn the rudiments of a programming language (commands, formats, etc.) while quickly achieving an activity usable in the classroom. This postpones until later the more difficult tasks of developing program algorithms. In the meantime, valuable classroom experiences with computers can be derived in the instructional environment. These piloting experiences help rapidly to build perceptions of those applications of a computer likely to be of maximum personal use.

The teacher educator has a particularly difficult problem in providing appropriate resources during this implementating stage. This is most easily solved in cases where the teacher training can be exported to the audience's school and computing equipment already is there for use. Where either of these conditions is not present, the teacher educator must take steps to insure that efforts expended on pilot implementations can easily be transferred to the eventual equipment and software configurations installed at the schooling site.

A successful curriculum map for inservice training at the implementation stage is shown in Figure 3. This plan is built around the content of the monographs ISEAC 2e-20e of this series. Note that the curriculum plan reflects the central theme of a teaching subject characteristic of an experienced teacher. Integrated with this focus are the detailed studies of the various instructional computing styles as they are deemed appropriate to the particular teacher and subject. Note also that this plan includes provision for informational resources to those implementing teachers also involved in initial computer resources procurement. These teachers will require a wide variety of information about hardware, software, and applications. Particularly, they usually will need extensive consultation and assistance in relating desired computing tasks to equipment needs. (Two helpful sources of such information are ISEAC'S 14e and 15e.)



CURRICULUM MAP FOR
IAC TRAINING
(IN-SERVICE)

FIGURE 3

To date, only a few teachers at the pre-college level have progressed to what we are calling the maintenance or growth stage of instructional computing expertise. It is at this stage that the teacher ceases somewhat incidental computer instruction activities or experiments and instead, establishes and sets about to achieve a major role for the computer in the classroom environment. That role may range widely depending upon the teaching strengths or interests of the teacher, the nature of the subject, the teacher's view of the objectives of the subject, etc. One teacher, more oriented toward individualized instruction, may set about the creation and implementation of an elaborate instructional management facility. Another teacher, wishing to emphasize a minimal level of performance in processes or procedures of the subject, may design and implement several simulations. A department, wishing to improve and to expedite its testing program may set about creating a computerized test item banking/test construction system. A group of foreign language teachers, wishing to inject into their program another dimension to culture education, may elect to construct simulations of trips to foreign lands--each decision in such a simulation providing information about economic, religious, social, or political characteristics of the country and the implications of same for the traveler. The possibilities for intensive individual or group projects at this stage are boundless.

The value of the teacher educator at this stage is in preventing reinvention of wheels. Normally, these "wheels" take the form of computer software systems specifically tailored to achieve certain instructional styles. A teacher at this stage must try to avoid the need to create, for example, an instructional management system itself. Several such systems, adaptable to a wide variety of equipment, are available. The specific curricular materials on which such a system would function are the more proper focus and concern of the teacher.

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